

- IV. "An Instrument of Precision for producing Monochromatic Light of any desired Wave-length, and its Use in the Investigation of the Optical Properties of Crystals." By A. E. TUTTON, Assoc. R.C.S., Demonstrator of Chemistry at the Royal College of Science, South Kensington. Communicated by Professor THORPE, F.R.S. Received January 11, 1894.

(Abstract.)

This instrument enables the whole field of any optical instrument whose aperture does not exceed 2 ins. to be evenly and brightly illuminated with monochromatic light of any desired wave-length. It has been devised especially for use in connexion with the axial angle polariscopical goniometers, spectrometers, stauroscopes, microscopes, and other instruments employed for the investigation of the optical properties of crystals, but is capable of much more extensive application. It was suggested by the apparatus described by Abney ('Phil. Mag.,' 1885, vol. 20, p. 172), but differs from that arrangement in most of its details, and particularly in the employment of a fixed instead of a movable exit slit, of a rotatory instead of a fixed dispersing apparatus, which is capable of accurate graduation for the passage of rays of definite wave-lengths through the exit slit, and in the manner of utilising the issuing line of monochromatic light, which, instead of being directed upon an opaque white screen, is diffused so as to be evenly distributed over the field of the observing instrument when that instrument is placed directly in its path.

The instrument resembles a compact spectroscope in appearance, and is constructed to pass a large amount of light. Upon a strong stand, furnished with levelling screws, a fixed horizontal circle, carrying a vernier, is supported. About this circle two exactly similar optical tubes are capable of counterpoised rotation; they carry at the ends nearest the centre of rotation corrected lens combinations of 2 ins. aperture and only 9 ins. focal length, and at the other ends a special form of slit, capable of accurate adjustment to the foci of the lenses by rack and pinion movement. The lenses of each combination are not cemented together by balsam, but are held in metal frames, separated by a small air-space, so that they cannot be injured by the heat rays from a powerful source of light, and no alum cell is required. The slit-jaws are capable of equal movement on each side of the central line, so that, however wide the aperture, its centre remains fixed. They may also be removed altogether and replaced by a slider carrying two or three slits whenever it is desired to use composite light; upon replacement they are made to fall exactly into

their former places, so that their adjustment is unimpaired. A large width of slit, 1 in., is provided for use when imperfectly transparent crystals are under observation whose dispersion of the optic axes for different colours is small, so that a slight curvature of the lines of light vibrating with the same wave-length is immaterial; but stops of $\frac{5}{8}$, $\frac{1}{2}$, $\frac{3}{8}$, and $\frac{1}{4}$ in. respectively are also provided, the two smaller of which are intended for general use, and furnish lines apparently perfectly straight. Above and parallel with the fixed circle a second one, which is divided and carries the dispersing apparatus, is capable of rotation. The latter consists of a single 60° prism with truly worked and specially large faces, $4\frac{1}{2}$ ins. by $2\frac{1}{2}$ ins., in order to fully utilise the light from the 2-in. objective. A single prism is of advantage for the purpose in view, affording more light and the minimum curvature of spectral lines; in order that the dispersion shall not suffer thereby, the prism is constructed of dense glass possessing the highest dispersion compatible with perfect freedom from colour, and which will enable the whole of the visible spectrum to be brought between the edges of the exit slit by rotation of the prism without materially sacrificing light by reflection.

As the optical tubes are exactly similar, either may be chosen as collimator. To a tapped annulus projecting from the slit frame of the one chosen the carrier of an adjustable mirror is attached, and sunlight reflected along the axis of the tube. The other optical tube is then converted into a telescope by the similar attachment of one of three provided eyepieces, which are constructed to focus the edges of the slit immediately in front. The clearly-defined edges thus serve the purpose of a pair of cross-wires between which any solar line may be adjusted. By arranging the prism and telescope so that the beginning of the ultra-violet is adjusted centrally for minimum deviation, it is possible by rotation of the prism to bring the whole of the spectrum past the exit slit. The readings of the prism circle are then taken for the positions when prominent solar lines are adjusted between the closely-approximated edges of the slit, and these readings supplemented by those for the red lithium and green thallium lines, and the whole expressed in a table and by a curve. The mirror and eyepiece are then removed.

Upon illuminating the receiving slit with any artificial source of illumination, light of any wave-length may be made to issue from the exit slit by setting the circle to the reading corresponding to that wave-length. Either the electric arc, limelight, or improved burner and zirconia mantle of the "incandescent gaslight" may be employed, best in a lantern, the condensers of which are sufficient for condensing the rays upon the slit. The opening of the latter need not exceed $\frac{1}{15}$ in. with the feeblest of the three sources, and that of the exit slit may be still finer. If either of the two first-mentioned

sources are employed, the apertures may be exceedingly fine, and the monochromatism is of very high order.

To diffuse the issuing light, a tube of 2 ins. diameter and equal length, carrying within it either of two diffusing screens of ground glass, of fine and extremely fine texture respectively, is attached to the tapped annulus of the frame of the exit slit by a suitable carrier, which enables the tube to be approached as near to the slit as desired by sliding along a bar. The instrument to be illuminated, the polariscope of the axial angle goniometer for instance, is brought close up, so that the end of the polarising tube enters the diffusing tube and almost touches the ground glass screen, which is best distant about $1\frac{1}{2}$ ins. from the slit; the axes of the optical tubes of the two instruments should of course be made continuous. The illumination of the field of the polariscope, when carrying an adjusted crystal section-plate between its convergent lens systems, is so bright that measurements of the optic axial angle can be carried out with light as far as G, and is greatly superior to that obtained by the use of coloured flames. The interference figures are wonderfully sharp upon a homogeneously coloured and illuminated background.

Cases of crossed axial plane dispersion can be completely traced from the extreme separation of the axes for red in one plane to their extension for blue in the plane at right angles, and the exact wavelength for the crossing point when the biaxial crystal simulates an uniaxial one at once determined.

The instrument is equally adapted for use in the determination of refractive indices by the methods of refraction or total reflection; the refracted images of the slit of the spectrometer are immensely brighter than when coloured flames or a hydrogen Geissler tube are employed. A great saving of time is effected in all these measurements, and this is especially advantageous in observations for different temperatures. Full details of the mode of employing the instrument for these various observations, and for its use in stauroscopical determinations of extinction angles, are given in the memoir.

V. "On Hollow Pyramidal Ice Crystals." By KARL GROSSMANN, M.D., F.R.C.S.E., and JOSEPH LOMAS, A.R.C.Sc. Communicated by Professor JUDD, F.R.S. Received January 4, 1894.

(Abstract.)

I. *The Lava Cavern, Surtshellir*.—At a visit to the lava cavern, Surtshellir (Iceland), in June, 1892, the farthest recess, which contains ice stalactites and an ice pond, was found to be covered on walls and ceiling with ice crystals in the form of hollow hexagonal